## Question 2:

You are designing a stylish fan that uses only one blade. Approximate that blade as a narrow plate with density per unit length of 20g/cm. The base weight of the rest of the device (except for the blade) is 4 kg, and the whole thing is mounted on a lightweight beam. If the spring constant of the beam is $k = 1000$ N/m, find the length of blade than will cause resonance if the fan is designed to spin at $\omega = 15$ rad/s.

spring
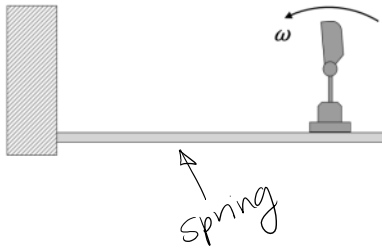
$$m_T = M + m \qquad k = 1000 \, N/m$$

$$\omega_n = \sqrt{\frac{1000 N/m}{m_T}} = \sqrt{\frac{1000 \, N/m}{4kg + m}} = \sqrt{\frac{1000 N/m}{4kg + 2\ell}}$$

$$m = \rho \ell$$
$$= \frac{20g}{cm} \cdot \frac{100cm}{m} \cdot \frac{1kg}{1000g} \cdot \ell$$
$$= 2\ell$$

For resonance: $\omega_0 = \omega_n$ $\omega_0 = 15 \, rad/s$

$$\omega_0 = 15 rad/s = \sqrt{\frac{1000 \, N/m}{4kg + 2\ell}}$$

$$225 = \frac{1000}{4 + 2\ell}$$

$$900 + 450\ell = 1000$$
$$450\ell = 100$$
$$\boxed{\ell = 0.22 \, m = 22 \, cm}$$